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COMMENTS ON VOL. 4, E.I.S. (BIOLOGICAL AND PHYSICAL EFFECTS)

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In addition to a number of lesser concerns [redacted] I have a number of comments which I think should be more fully addressed. I believe that the calculations of the zones of influence of underwater noise (pages 2.40 & 2.41) are incorrect. Possible damaging effects of loud noises are mentioned (page 2.31) but not discussed. The cumulative effect of manyloud sources (Tables 2.3-7 and 2.3-9) are not fully discussed. The endangered status of the bowhead whale is often mentioned but, again, not fully discussed, especially with regard to the Bering Sea stock and the other pressures this stock is facing. The possible cumulative effects of various minor impacts [redacted] on a species are not discussed. Sound propagation and ambient noise levels in the Beaufort Sea (pages 2.30 and 2.31) should have been measured under a variety of conditions (1981 workshop, page 338).

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Aspects related to the Zone of Influence Calculations.

The zones of influence of underwater noise on the hearing and communication abilities of ringed seals can be calculated using the information on critical ratios (page 4.16), noise level estimates (page 4.14) and the underwater hearing sensitivity of ringed seals (Terhune and Ronald, 1975b). Ambient noise mearurements (Table 2.3-10) indicate that ambient noises will not be influencing the hearing of ringed seals during quiet periods at least.

From the information given on page 2.40, I interprit that the zones of influence were calculated by determining the point at which the spectrum level of the noise from the icebreaking tankers (as given on page 4.14) was the same as the pure tone hearing threshold of the ringed seals. This is not correct however, as when the spectrum level of a broad band noise is the same level as the pure tone detection threshold, the pure tone detection threshold is raised by an amount equal to the critical ratio (page 4.16). Thus, if the spectrum level of a noise is as loud as the unmasked pure tone detection threshold, the hearing of the subject will be significantly masked.

At 1 kHz, the hearing threshold for a ringed seal will be about 75 dB/uPa (Terhune and Ronald, 1975b). If it is assumed that the critical ratio at 1 kHz would be 20 dB (a conservative estimate, see page 4.16) then the masking of a pure tone would occur when the spectrum level of a broad band noise reaches 75-20= 55dB/uPa (spectrum level). At 1 kHz, the ambient noise in the summer reaches at least as low as 40 dB/uPa (spectrum level) and as low as 57 dB/uPa (spectru level) in the winter (page 2.31). In the summer, the noise from the icebreaking tankers would reach 55 dB/uPa (spectrum level) at a distance of 60 km. In the winter, at a distance of 60 km (20 m depth) the vessel noise would be masking the pure tone hearing thresholds by 71-55 = 16 dB. Assuming that beyond 60 km a 6 dB loss is experienced each time the distance from the source is doubled, (spherical spreading loss) then at a distance of 240 km (60 x 2 x 2) a 12 dB spherical spreading loss would have occurred. Thus in the summer the zone of influence of the underwater sound at 1 kHz would be a radius of 60 km from the vessel and in the winter the distance would be a radius of 240 km. These distances are far above the 8 and 50 km distances suggested on page 2.41. In a 30 dB critical ratio is assumed, the distances would more than double (i.e. 120 and 480 km).

Assuming that 4 and 5 kHz are close enough to be interchangeable, it is similarly possible to calculate the estimates of the zones of influence of underwater noise at 5 kHz. The hearing threshold of the ringed seals at 4 kHz is 75 dB/uPa and the critical ratio is 30 dB. The level of ambient noise in the summer and winter will be AS LOW AS 32 dB/uPa (spectrum level) (page 2.31). Boat noise will mask the pure tone detection thresholds if it is above 75 - 30 = 45 dB/uPa (spectrum level). This level is reached in the winter at about 50 km and in the summer at about 20 km. Again, these distances are well above the 4 and 2 km distances given on page 2.41.

When 2 animals are acoustically communicating underwater, in addition [redacted] TO absorption losses etc., sound levels will decrease by 6 dB (assuming spherical spreading loss) each time the distance between the two animals is doubled. For example, in the vocalizations of [redacted] an animal 100 m away are 36 dB above the hearing threshold of the listener, then they would be 30 dB above threshold at 200 m and 24 dB above threshold at 400 m. An important aspect of this is that with every 6 dB loss in sound level, the distance over which 2 animals can communicate is cut in half. Thus if the maximum communication distance for a species is 1 km (that is, in a quiet, un-masked situation, the sound level of a sender's vocalizations are attenuated to the level of the receiver's detection threshold) then if the receiver's hearing threshold is masked by 6 dB (through an increase in background noise) the communication distance would be cut in half.

Assuming spherical spreading loss only, a 60 dB loss will occur when a sound travels 1024 m. [redacted]. Assuming that the source level of seal underwater calls at 1 kHz are in the order of 140 dB/uPa, then these calls will be 140 - 75 = 65 dB above threshold (see page 4.21). Thus at 1 kHz, an inter-animal communication distance of 1 km should be possible. [redacted]

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The inter-animal communication distance [redacted] loss can be expressed as a fraction of the original maximum distance (Z) using the equation $Z = 10^{-X/20}$ (where X = dB). Thus if the ambient noise if raised by 20 dB, the communication distance drops to $10^{-20/20} = 10^{-1}$ = 0.1 of the maximum distance. Using assumed critical ratios of 20 or 30 dB and an assumed maximum communication distance of 1000 m, the inter-animal communication distance losses which would occur at 1 kHz at a depth of 20 m, are given below.

R 1 kHz INTER)	Distance from source	noise (spectrum level) dB/uPa	masked threshold level dB/uPa	threshold increase (dB)	maximum communication distance (metres)
ssuming ritical atio 20 dB	1 metre	148	168	93	0.02
	1 km	92	112	37	14.1
	10 km	85	105	30	31.6
	60 km	71	91	16	158.5
suming itical atio 30 dB	1 metre	148	178	103	0.01
	1 km	92	122	47	4.5
	10 km	85	115	40	10.0
	60 km	71	101	26	50.1
For 4-5 kHz (winter)	1 metre	137	167	92	0.03
	1 km	81	111	36	15.8
	10 km	62	92	17	141.3
	20 km	57	87	12	251.2
	50 km	75	75	0	1000.0
or 4-5 kHz (summer)	1 metre	133	163	88	0.04
	1 km	73	103	28	39.8
	10 km	49	79	4	630.9
	20 km	45	75	0	1000.0

For the 1 kHz situation in summer, at 60 km the 56 dB/uPa (spectrum level) produced by the vessel would raise (mask) the hearing threshold by only 1 dB if the critical ratio is 20 dB. If the critical ratio is 30 dB then the threshold would be raised by 10 dB and this would result in a maximum communication distance of 316.2 m. Assuming a 20 dB critical ratio and that the noise of the ship IN THE WIN drops 6 dB between 60 and 120 km, the threshold increase is also 10 dB so the ~~[illegible]~~ communication distance would, at 120 be 31.6% of maximum. If the critical ratio is 30 dB, at 120 km the maximum communication distance would be 100 metres.

Thus, for ringed seals, and in a similar manner for other marine mammals, the noise of loud vessels will result in a reduced communication distance even though the vessel is some distance away. In the summer, communication will be interferred with even if the vessel is 60 km away (1 kHz). At the slightly higher frequency, masking may occur at distances of 10 to 20 km, depending upon the season. The worst case situation for the winter would be if the critical ratio at 1 kHz is 30 dB. In this case, the communication distance would be reduced to about 10% of maximum when the vessel is 120 km away. Assuming a tanker every 250 km along the route (page 4.21) there would be no time when the ringed seals ALONG THE ROUTE could engage in "normal conversation" during the winter. Even with lower vessel numbers and the tankers 1000 km apart (page 2.40) there would be a large percentage of the time when communication distances would be severely reduced.

Natural background noise levels are thought to increase the seals' detection thresholds (Terhune and Ronald, 1972). While it may be argued that marine mammals are often subjected to loud sound levels which would interfere with their communication distances, if these sounds are not continuous, the animals may be able to communicate during quiet periods. Thus, the times and durations of quiet periods may well be of paramount importance. Industrial noises which occur during these quiet periods would possibly be blocking the signals during the only possible times they would normally be passed. If the various marine mammal species require acoustic contact for courtship purposes, a reduced communication ability would likely lessen reproductive success. While this may not greatly influence the ubiquitous ringed seal it certainly could severely influence any of the less populated species.

Blocking a communication channel will undoubtedly result in some behavioural changes (otherwise the system would not have evolved). Provided that the noise is not too loud, a blocked acoustical channel may not interfere with some of the aspects of day-to-day life of marine mammals. It may, for example, be possible to feed in a noisy area, especially if the animals can remain within visual contact. If the species uses acoustical communication to keep the herd intact or for other important tasks, the blocking of that channel may be noticeably detremental. Ultimately the detremental effect would show up in reduced population levels (where such are detectable!). In the short term, overt behavioural and/or distribution patterns may occur. For example, when exposed to ship noises, the vocalization behaviour of harp seals has been observed to have significantly changed (Terhune, Stewart and Ronald, 1979, Can. J. Zool. 57:1337-1338). In this study, the vocalizations decreased the day after a vessel arrived in the area. This change was observed on two consecutive years. While it is not possible to determine if the change in vocal behaviour was also associated with reduced reproductive fitness etc. the mere fact that the seals behaved abnormally suggests a detremental situation.

The harp seal study also indicated that seals may not necessarily "habituate" to industrial noise. The mere presence of seals or cetaceans in an area cannot be taken to mean that they have habituated (without any ill effects) to a noise source. Animals (including humans) will often subject themselves to uncomfortable or dangerous situations in order to obtain the necessities of life. Loud noises have failed to scare seals away from salmon nets. Seals and cetaceans are often seen near vessels and harbours. No studies have shown however that these animals are as fit as their counterparts in more pristene areas. Harbour seals for example, are regularly seen adjacent to the harbour of Saint John, New Brunswick. These seals haul-out regularly on a set of offshore ledges. It appears that they spend much of their time while hauled out scanning for predators (up to 86% for single animals). Harbour seals in California are reported to sleep while hauled out. The latter will certainly save much more energy than the former activity. Thus the Saint John harbour seals cannot be said to have become "habituated" to the nearby human and industrial activity.

Aspects Related to Overall Loudness Levels.

Wide band sound levels of 192 dB/uPa (page 4.13) will be about 110 to 120 dB above the most sensitive threshold of seal hearing. Thus, seals escaping into the water when the icebreaker traverses their immediate area (and crushes some of their pups) will be subjected to loudness levels at or near the pain threshold. Such an intense exposure may well have a significant influence on the behaviour of the animals long after the tanker has past.

The loud noise may also cause deafness which in turn would severely reduce the fitness of the seal or whale. Human standards for noise exposure are as follows;

Steady noise level (dB(A) scale)	exposure time (hours)
90	8
95	4
100	2
105	1
110	½
115	-

It is not inconceivable that noise levels of sufficient magnitude to cause hearing loss will occur in the Beaufort Sea. Table 2.3-7 lists the numbers of ice-breaking tankers, supply vessels, ice brakers and tugs which might be in place by the year 2000. The low number (c) is 59 and the upper number is 101 (a). Various dredges and other work boats will increase the number of noise sources to 89 to 137. The noises from these vessels will not only mask the hearing of marine mammals but may well create sound levels high enough to cause "industrial deafness".

The Bowhead Whale, an Endangered Species.

The Bering Sea stock of the bowhead whale is subjected to a (controversial) annual hunt. The population levels of this group of animals is poorly known (I.W.C. Special Report No. 4). The 1978 population estimate was between 1783 and 2865 whales. The population structure was believed to be such that "the stock must decline even in the absence of catching." (page 79). The 1980 census estimated between 1483 and 1786 whales. The 1981 census led to estimates of 2025 to 2459 whales but "The 1978 estimate of 1,738-2864 is still considered the most accurate." (page 83). With special regard to the annual harvest of bowheads, the IWC stated "Information on the bowhead whale is inadequate to provide any satisfactory guide to management of this population with a non-zero quota" (page 2). "The Committee also re-emphasized the serious consequences of a high rate of exploitation on a small stock which may suffer environmental perturbations, and noted the dangers resulting from such events as ice entrapment, in addition to man-made pollution effects." (page 2). One of the guidelines suggested for bowhead whale management by the IWC is "2. Management should provide for the identification and maintenance of critical habitats (e.g. breeding, calving, nursing, feeding grounds) and migration routes throughout the geographic range of the Bering Sea stock of bowhead whales." (page 19).

I question whether the endangered status of the bowhead whale has been fully and thoroughly considered. The statement "the bowhead stock includes at least 2,300 individuals" (page

2.85) appears open to serious question. The variability of the numbers arrived at for the 3 population estimates reported in the IWC report also indicate that it is not really possible to obtain an extremely accurate population estimate for bowheads. Thus, the"additional monitoring programs" indicated on page 2.42 may not be of much real value. If the best bowhead population estimate listed in the IWC book has a 40% spread and could not be repeated with the same degree of accuracy for the next two attempts, how can any monitoring program reveal anything except a catastrophic decline in the bowhead numbers?

Matrix 2.5-1 lists 5 minor potential impacts relating to bowhead whales. Considering the lack of knowledge re. the biology of the bowhead whale, the very real possibility of a continued harvest, the low numbers of animals in the Bering Sea stock (and in other stocks), is it really possible to assign a detremental effect a "minor" status? Could the cumulative influence of the 5 "minor" impacts result in major impact? If it is true that the stock will decline even in the absence of a harvest (IWC report No. 4) then any ADDITIONAL impact will almost certainly be "major", by definition (page 1.3).

In some cases it may be possible to take "mitigative measures" which will be successful; what will happen if the bowhead populations crash? Will the blame for the loss of this species be apportioned out amoung the various scapegoats? Throughout the E.I.S. there are many optomistic statements. They are as easy to defend (in the lack of any real knowledge) as a group of pessemistic statements.

If however, the optomism is not well founded and the bowhead populations are seen to begin to decline drastically, I cannot see the various operations being able to(financially) withdraw. In some sections of the EIS statement, there is a clear indication that biological considerations will take second place to other considerations. For example, on page 4.5 the problem of the tankers running through the main whelping areas of hooded seals in Davis Straight is addressed. "To mitigate possible impacts on hooded seal pups the proponents will use real-time data to establish the location of the whelping patch, and WHENEVER POSSIBLE, restrict the tankers from traversing these areas." (Emphasis is mine; page 4.5). There will always be a pressure to enhance crew and ship safety, reduce operating costs, increase production, show visitors and clients the various wildlife species etc. etc. Will the bowhead be too expensive? I suspect that it will.

Comments on Vol. 1, Summary.

On page viii, the statement "Important animal habitats will be avoided whenever possible." is made. The paragraph goes on to state that changes will be made to incorporate different mitigative measures. Would it be possible to identify some realistic limits in terms of population numbers or impact levels? Admittedly the annual variation of numbers of marine mammals (and other species) in any one area, coupled with the difficulties of obtaining useable population estimates, would make this a difficult task. The whole monitoring program mentioned on page xi will not, in itself, correct any problems. While some mitigative measures may be possible, such changes will only be effective where both the disrupting factor can be clearly identified and the mitigation procedure will be economically, socially or technically realistic.

I agree with the response (page xii) to aircraft noise (both here and in Vol. 4). Hopefully altitude and route restrictions will be enforceable and enforced (via company policy and appropriate legislation).

One problem with the underwater noise generation is that, unlike a spill, it is a continual by-product of normal operations. Even if monitoring effects determine the level of disturbance, little could be done to alleviate the problem. I do not agree with the statement that "No serious effects have been identified to date and none are anticipated." (page xii). Matirces 2-1 and 2-4 indetify a total of 14 negligible and 10 minor impacts related to underwater noise. The bowhead is listed as receiving 3 minor ratings. Table

3-1 lists 18 negligible, 11 minor and 5 moderate impacts of which 3 minor and 1 negligible are for the bowhead. (Note, these include disturbance and mortality factors in most cases). With a possible 6 minor impacts related to underwater sound, the effect on the bowhead whale must be considered as serious.

The statement "Some seal pups will be killed." on page xii may raise a red flag in an unexpected corner. Considering the current furor surrounding the harp seal "hunt" and the number of organizations actively (and lucratively) involved in that controversy, I suspect that while the impact to some seal groups may be minor to moderate, the impact to the proponents, and Canada, could well be major. The harp seal hunt is well regulated and policed and benefits from probably the most accurate population assessments of any marine mammal species. It has ESSENTIALLY been stopped by public opinion. The scientific and economic aspects of the harp and hooded seal hunts did not play a major role in the controversy. It was the clubbing of babies that seems to have been of paramount importance. I suspect that "crushing baby seals and their mothers and leaving them to die a slow, agonizing death etc." will attract the attention of a number of powerful interest groups. While it may not come to a movie star beside every seal pup along the tanker route, a determined few could take up the cause and attract a lot of media attention. The well funded protest machinery is in place, a victory has been won and new causes are needed to fill the vacume. While the accidental death of young seals may receive the same scientific and industrial interest as the porpoise-tuna problem in the U.S.A., it must be recognized that some legitimate concerns related to animal welfare or cruelty do exist (simply because animals are being killed). These concerns will have to be dealt with at the emotional as well the scientific or technical level.

The bowhead population levels are given as "about 2300" on page 2.7 and as "at least 2300" on page 2.16. The I.W.C. gives the best population estimate as 1783-2865 with a mean of 2264 in 1978 (page 79, International Whaling Commision, Special Issue No. 4, 1982). The probability of there being only 1783 bowheads in the region is the same as it is for population levels of 2264, 2300 or 2865. This level of inaccuracy is typical of most marine mammal population assessments. The variability of ringed and bearded seal numbers (page 2.7) reflects animal movements and problems in population assessment. For example, 23,000 to 62,000 ringed seals is a 270 % increase so a 50 % fluctuation in seal numbers would possibly go un-noticed. The 2385% range in bearded seal numbers also would mask a significant change in their real numbers. Thus using population numbers as a means of monitoring populations and impacts has an inherent degree of inaccuracy which may well preclude the usefullness of the technique. Also, populations would be expected to change after the impact has occurred and thus, in the case of the endangered bowhead for example, may be too late to permit successful mitigative measures.

Numbers present some indication of what has happened but other parameters may also be valuable. Blubber-thickness/fitness, pregnancy rates, distribution, emmigration/immigration rates etc. may show trends before a major impact is fully expressed. Various behavioural pattern changes may suggest that reproductive problems are likely to occur in the near future. Unfortunately, it is virtually impossible to follow marine mammals (undetected) while they are underwater. They can hear acoustic devices and radio waves are rapidly absorbed by sea water. Thus, it will not be possible to determine if some changes are occurring in their underwater behaviours. While some data on bowheads may be obtained from carcasses (in Alaska) the data base will be small and the selection of individuals somewhat biased. Considering the dearth of knowledge surrounding so many marine mammal activities, establishing an estimate of the influence of a changed environment may well, in the absence of knowing the "natural" situation, not be possible. To date, I have not seen Vol. 7 REsearch and Monitoring, which would obviously consider this problem in some detail. The summary volume does not list specific objectives of precise programs. If the majority of the effort is to be put into population assessment projects I fear that the resulting data will be inadequate to fully assess the impact of this on-going project.

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